MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023

EEL 3146 – ELECTRIC POWER UTILIZATION AND INSTALLATION

(LE)

05 JULY 2023
9.00 AM – 11.00 AM
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 11 pages including cover page with 4 Questions only.

2. Answer ALL questions. All questions carry equal marks and the distributions of the marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

Question 1

Design a lighting system for a cafeteria. Energy efficiency must be given priority during the design work. Show all the details including the plan view with location of lights.

Length: 20 m
Width: 15 m
Height: 5 m
Working surface to ceiling height: 4.3 m

Maintenance Factor- 0.7
Reflectances – Ceiling (0.7), Walls (0.5), Working plane (0.1)
Space Height Ratio – 1.16

Note: Refer to Appendixes A1 to A3.

[25 marks]

Question 2

Following are the connected loads in a typical house with a single-phase supply, 230 V, 50 Hz.

10 numbers of 20W Lighting Points
2 numbers of 2500W Water Heater Point
2 number of 2500W Air Conditioning Points
6 numbers of Switch Socket Outlet, S.S.O (Highest possible load 2000W, the rest 300W)

a) Design wiring circuits for loads above. Size the MCB and cable for each load (5 lighting points per circuit, and 2 x S.S.O per circuit). All installation using PVC conduit and concealed inside wall.

[12 marks]

b) Construct the single line diagram for the installation. Use the diversity factor given in Appendix B5.

[13 marks]

Note: Refer to Appendixes B1 to B5.

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Question 3

a) Calculate the specific energy input for the train which is used to travel within city. Following are the train and operation details.

Weight: 80 Ton with 5% Rotational Inertia
Efficiency of Motor used is 80%
Track resistance is 6 kg/ton.
Gradient: 1% for 0.5 km.
Distance between station is 3.0 km
Acceleration is 3 km/hr/sec
Acceleration time 20 sec
Deceleration time 15 sec

[17 Marks]

Given specific energy output equation as below

$$E_T = \frac{0.010726V_m^2}{D}\left(\frac{M_e}{M}\right) + 0.2778\, r\, \frac{D'}{D} \pm 27.25\, G\, \frac{D'}{D}$$

b) State four (4) ways how the electric energy supplied to the train is spent.

[8 Marks]

Question 4

a) State and describe three (3) modes of heat transfer.

[9 Marks]

b) A direct arc furnace is used to melt steels. The furnace draws 10000 A to melt 35 ton of steels within 8 hours. Calculate the average input power for the furnace and the total energy used by the furnace in a month (20 hours operation for 30 days in a month).

Following are the parameters for furnace and steel.
Ambient temperature is 40°C
Specific heat of steel is 0.13 kcal kg^{-1} $°C^{-1}$
Latent heat of steel is 9 kcal/kg
Melting point of steel is 1371°C
Efficiency of Furnace is 75%
Given 1 kWhr = 860 kcal)

[16 Marks]

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Appendix A1: MS 1525:2014

Table 10. Recommended average illuminance levels

Task and Applications	Illuminance (Lux)
a) Lighting for infrequently used area:	
- Minimum service illuminance	20
- Interior walkway and car-park	100
- Hotel bedroom	100
- Lift interior	100
- Corridor, passageways, stairs	100
- Escalator, travellator	150
- Entrance and exit	100
- Staff changing room, locker and cleaner room, cloak room, lavatories, stores.	100
- Entrance hall, lobbies, waiting room	100
- Inquiry desk	300
- Gate house	200
b) Lighting for working interiors	
- Infrequent reading and writing	200
- General offices, shops and stores, reading and writing	300 - 400
- Drawing office	300 - 400
- Restroom	150
- Restaurant, canteen, cafeteria	200
- Kitchen	150 - 300
- Lounge	150
- Bathroom	150
- Toilet	100
- Bedroom	100
- Class room, library	300 - 500
- Shop/supermarket/department store	200 - 750
- Museum and gallery	300
c) Localised lighting for exacting task	
- Proof reading	500
- Exacting drawing	1000
- Detailed and precise work	2000

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Appendix A2: Utilization Factor Table

Room Index k	Reflectances (%) for ceiling, walls and working plane (CIE)										
	0.80	0.80	0.70	0.70	0.70	0.70	0.50	0.50	0.30	0.30	0.00
	0.50	0.50	0.50	0.50	0.50	0.30	0.30	0.10	0.30	0.10	0.00
	0.30	0.10	0.30	0.20	0.10	0.10	0.10	0.10	0.10	0.10	0.00
0.60	0.37	0.35	0.36	0.36	0.35	0.30	0.30	0.27	0.30	0.27	0.26
0.80	0.44	0.42	0.44	0.43	0.41	0.37	0.37	0.34	0.36	0.33	0.32
1.00	0.51	0.47	0.50	0.48	0.46	0.42	0.42	0.39	0.41	0.39	0.37
1.25	0.56	0.52	0.55	0.53	0.51	0.47	0.47	0.44	0.46	0.43	0.42
1.50	0.60	0.55	0.59	0.57	0.54	0.51	0.50	0.47	0.49	0.47	0.46
2.00	0.67	0.59	0.65	0.62	0.59	0.56	0.55	0.53	0.54	0.52	0.51
2.50	0.71	0.62	0.69	0.65	0.62	0.59	0.58	0.56	0.57	0.56	0.54
3.00	0.73	0.64	0.71	0.67	0.64	0.61	0.60	0.59	0.60	0.58	0.57
4.00	0.77	0.66	0.74	0.70	0.66	0.64	0.63	0.62	0.62	0.61	0.59
5.00	0.79	0.68	0.76	0.71	0.67	0.66	0.64	0.63	0.63	0.62	0.61

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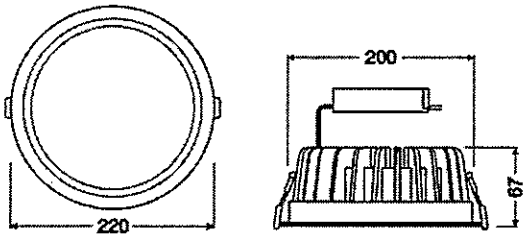
Appendix A3: Lamp Datasheet

Product family datasheet

LEDVANCE OSRAM

Technical data



Product description	GTIN (EAN)	Nominal wattage [W]	Nominal voltage [V]	Power factor [λ]	Luminous flux [lm]	Luminaire efficacy [lm/W]	Colour temperature [K]	CRI index [Ra]
Downlight LED 25W/3000K 230V IP20	4058075000068	25W	230V	>0.9	2220	90	3000K	>80
Downlight LED 25W/4000K 230V IP20	4058075000087	25W	230V	>0.9	2340	95	4000K	>80
Downlight LED 25W/6500K 230V IP20	4058075000100	25W	230V	>0.9	2440	100	6500K	>80

Product description	Beam angle	Rated life time L70 / B50 [h]	Type of protection IP rating	Protection class	Product size l x w or Ø [mm]	Height h [mm]	Body colour
Downlight LED 25W/3000K 230V IP20	100°	30000	20	II	Ø220	67	white
Downlight LED 25W/4000K 230V IP20	100°	30000	20	II	Ø220	67	white
Downlight LED 25W/6500K 230V IP20	100°	30000	20	II	Ø220	67	white

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Appendix B1: Time/Current Characteristics for Type C Circuit Breaker

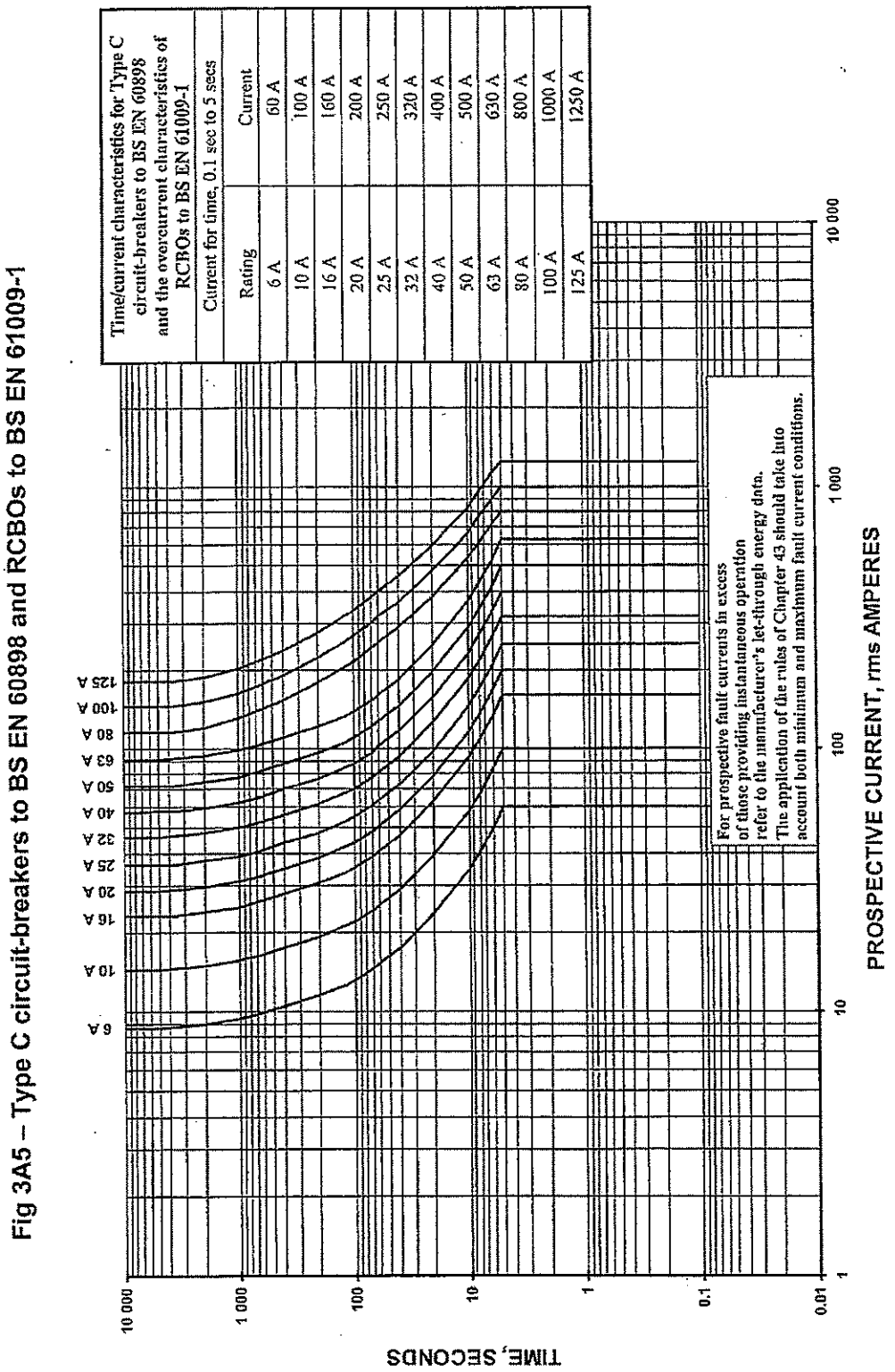

Fig 3A5 – Type C circuit-breakers to BS EN 60898 and RCBOs to BS EN 61009-1

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Appendix B2: Table 4D1A

TABLE 4D1A

Single-core pvc-insulated cables, non-armoured, with or without sheath
(COPPER CONDUCTORS)

BS 6004
BS 6231 Ambient temperature : 30 °C
CURRENT-CARRYING CAPACITY (amperes): BS 6346 Conductor operating temperature : 70°C

Conductor cross-sectional area	Reference Method 4 (Enclosed in conduit in thermally insulating wall etc.)		Reference Method 3 (enclosed in conduit on a wall or in trunking etc.)		Reference Method 1 (clipped direct)		Reference Method 11 (on a perforated cable tray horizontal or vertical)		Reference Method 12 (free air)		
									Horizontal flat spaced	Vertical flat spaced	Trefoil
	2 cables, single-phase a.c or d.c	3 or 4 cables, three-phase a.c	2 cables, single-phase a.c or d.c	3 or 4 cables, three-phase a.c	2 cables, single-phase a.c or d.c flat and touching	3 or 4 cables, three-phase a.c flat and touching or trefoil	2 cables, single-phase a.c or d.c flat and touching	3 or 4 cables, three-phase a.c flat and touching or trefoil	2 cables, single-phase a.c or d.c or 3 cables three-phase a.c	2 cables, single-phase a.c or d.c or 3 cables three-phase a.c	3 cables trefoil, three-phase a.c
1	2	3	4	5	6	7	8	9	10	11	12
(mm^2)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
1	11	10.5	13.5	12	15.5	14	-	-	-	-	-
1.5	14.5	13.5	17.5	15.5	20	18	-	-	-	-	-
2.5	19.5	18	24	21	27	25	-	-	-	-	-
4	26	24	32	28	37	33	-	-	-	-	-
6	34	31	41	36	47	43	-	-	-	-	-
10	46	42	57	50	65	59	-	-	-	-	-
16	61	56	76	68	87	79	-	-	-	-	-
25	80	73	101	89	114	104	126	112	146	130	110
35	99	89	125	110	141	129	156	141	181	162	137
50	119	108	151	134	182	167	191	172	219	197	167
70	151	136	192	171	234	214	246	223	281	254	216
95	182	164	232	207	284	261	300	273	341	311	264

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Appendix B3: Table 4B1

TABLE 4B1 – Rating factors (C_a) for ambient air temperatures other than 30 °C

Ambient temperature [a] °C	Insulation				
				Mineral [a]	
	60 °C thermosetting	70 °C thermoplastic	90 °C thermosetting	Thermoplastic covered or bare and exposed to touch 70 °C	Bare and not exposed to touch 105 °C
25	1.04	1.03	1.02	1.07	1.04
30	1.00	1.00	1.00	1.00	1.00
35	0.91	0.94	0.96	0.93	0.96
40	0.82	0.87	0.91	0.85	0.92
45	0.71	0.79	0.87	0.78	0.88
50	0.58	0.71	0.82	0.67	0.84
55	0.41	0.61	0.76	0.57	0.80
60		0.50	0.71	0.45	0.75
65		–	0.65	–	0.70
70		–	0.58	–	0.65
75		–	0.50	–	0.60
80		–	0.41	–	0.54
85		–	–	–	0.47
90		–	–	–	0.40
95		–	–	–	0.32

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Appendix B4: Table 4C1

TABLE 4C1 – Rating factors for one circuit or one multicore cable or for a group of circuits, or a group of multicore cables, to be used with current-carrying capacities of Tables 4D1A to 4J4A

Item	Arrangement (cables touching)	Number of circuits or multicore cables												To be used with current-carrying capacities, Reference Method
		1	2	3	4	5	6	7	8	9	12	16	20	
1.	Bunched in air, on a surface, embedded or enclosed	1.00	0.80	0.70	0.65	0.60	0.57	0.54	0.52	0.50	0.45	0.41	0.38	A to F
2.	Single layer on wall or floor	1.00	0.85	0.79	0.75	0.73	0.72	0.72	0.71	0.70	0.70	0.70	0.70	C
3.	Single layer multicore on a perforated horizontal or vertical cable tray system	1.00	0.88	0.82	0.77	0.75	0.73	0.73	0.72	0.72	0.72	0.72	0.72	E
4.	Single layer multicore on cable ladder system or cleats etc.,	1.00	0.87	0.82	0.80	0.80	0.79	0.79	0.78	0.78	0.78	0.78	0.78	

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Appendix B5: Diversity

Allowances for Diversity

Purpose of final circuit fed from conductors or switchgear to which diversity applies	*Individual household installation, including individual dwellings of a block*
1. Lighting	66% of total current demand
2. Power	100% of the total current demand up to 10 amperes + 50% of any current demand in excess of 10 Amperes
3. Cooking appliances	10 Amperes + 30% f.1 of connected cooking appliances in excess of 10 Amperes + 5 Amperes if socket outlet incorporated in unit
4. Water-heaters (instantaneous type)	100% f.1 of largest appliance + 100% f.1 of 2nd largest appliance + 25% f.1 of remaining appliances
5. Water-heaters (thermostatically controlled) And Air Con	No diversity allowable
6. Standard arrangements of final circuits using socket outlets	100% of current demand of largest circuit + 40% of current demand of every other circuit
7. Socket outlets other than those included in 6 above and stationary equipment other than those listed above	100% of current demand of largest point of utilisation + 40% of current demand of every other point of utilisation.

End of paper